Configuration and Management of Networks

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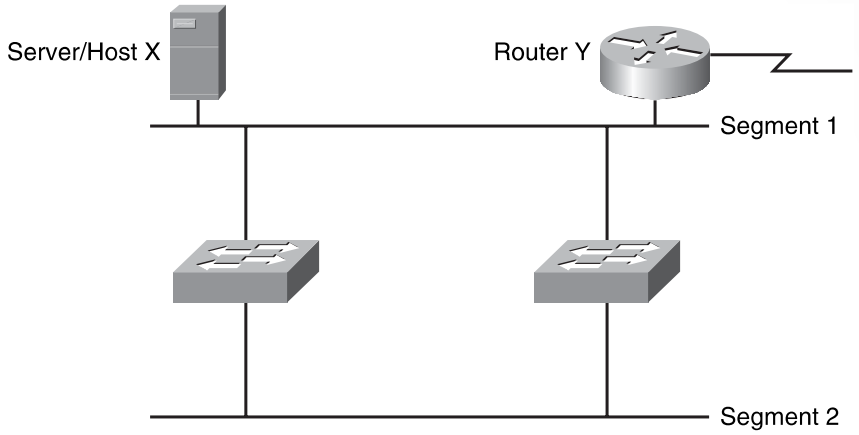
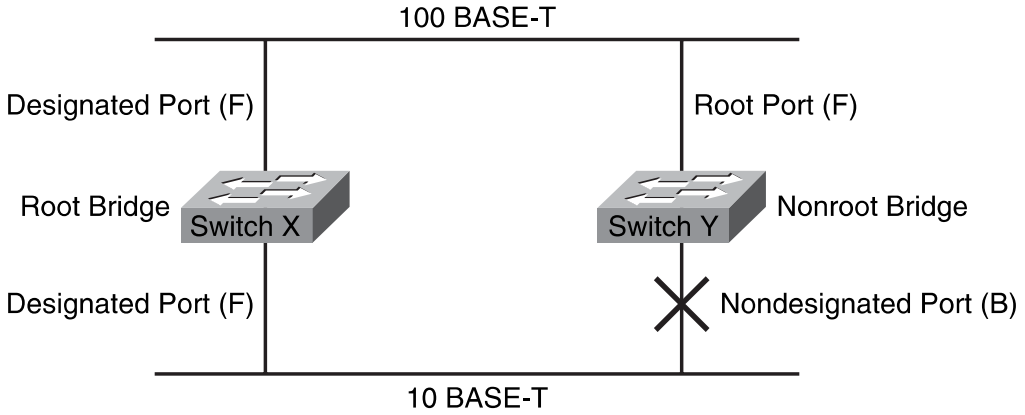
STP – Redundant topology



- **Broadcast storms:** Each switch or bridge floods broadcasts endlessly. This situation is commonly called a *broadcast storm*.
- **Multiple frame transmission:** Multiple copies of unicast frames may be delivered to destination stations
- **MAC database instability:** Instability in the content of the MAC address table results from copies of the same frame being received on different ports of the switch.

STP – Loop Avoidance

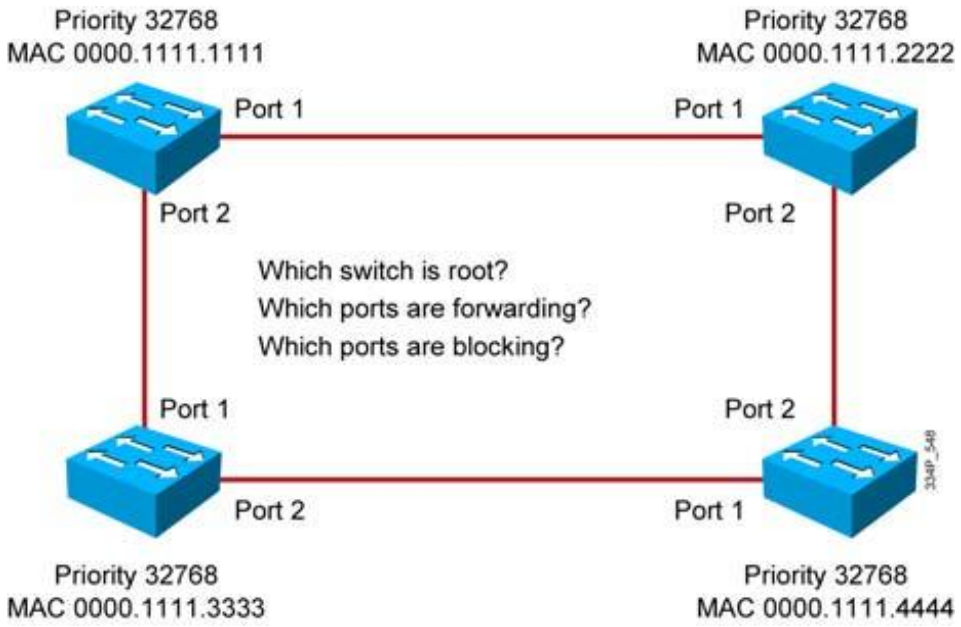


- **Elects one root bridge:** STP has a process to elect a root bridge. Only one bridge can act as the root bridge in a given network. On the root bridge, all ports are designated ports.

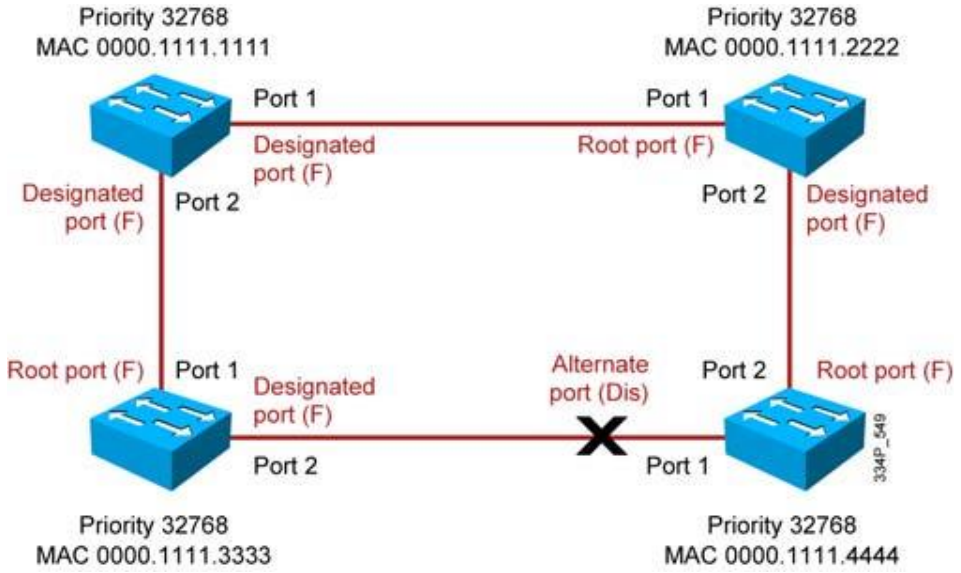
- **Selects the root port on the nonroot bridge:** The root port is the lowest-cost path from the nonroot bridge to the root bridge.

- **Selects the designated port on each segment:** On each segment, STP establishes one designated port. The designated port is selected on the bridge that has the lowest-cost path to the root bridge.

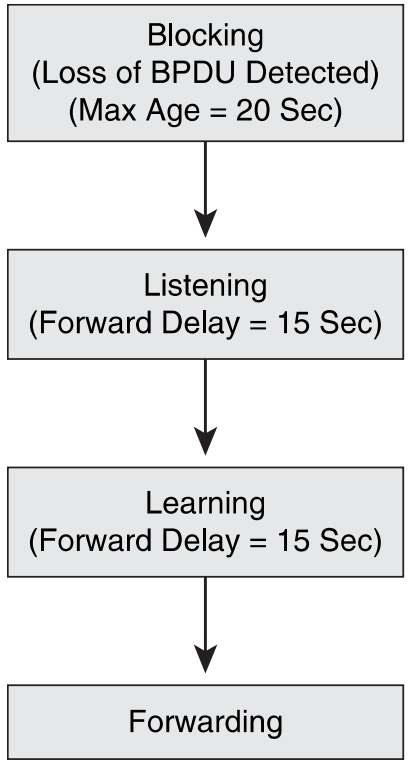
STP – Loop Avoidance



STP – Loop Avoidance



STP – Port States



Blocking ports only receive BPDUs

Blocking
(Moves to Listening
After It Decides
It Is a Root
Port or a
Designated Port)

Link Comes Up

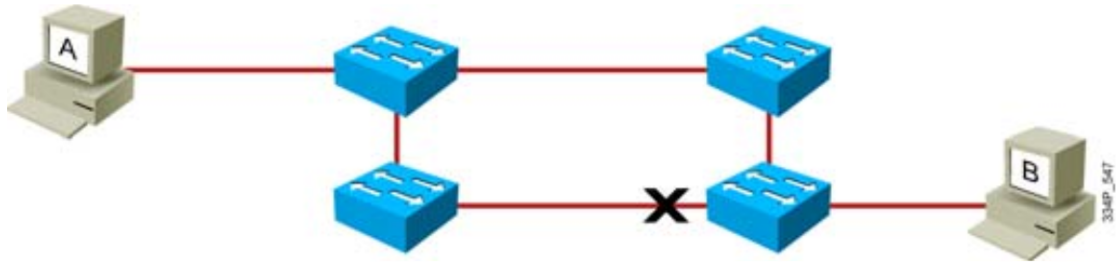
Listening ports receive and send BPDUs.

Learning ports only forward BPDUs. But learn Port–MAC mappings

Goal: Prevent loops while BPDU information propagates trough the Network.

STP – Standards

- 802.1D-1998: The legacy standard for bridging and STP.
- CST: Assumes one spanning-tree instance for the entire bridged network, regardless of the number of VLANs.
- PVST+: A Cisco enhancement of STP that provides a separate 802.1D spanning-tree instance for each VLAN configured in the network.
- 802.1D-2004: An updated bridging and STP standard.
- 802.1s (MST): Maps multiple VLANs into the same spanning-tree instance.
- 802.1w (RSTP): Improves convergence over 1998 STP by adding roles to ports and enhancing BPDU exchanges.

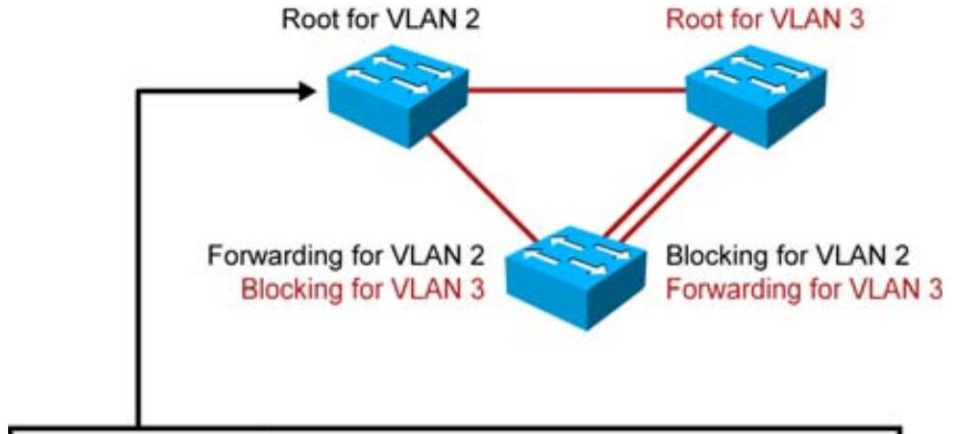


STP – Default configuration

- Default spanning-tree configuration:
  - PVST+.
  - A separate STP instance for each VLAN.
  - Same switch is root bridge for all VLANs.
  - No load sharing between links.

STP – implementing PVRST+

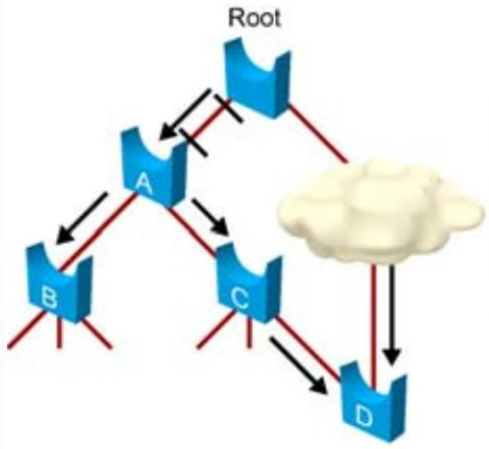
- Enable PVRST+ globally.
- Should be configured on all switches in the broadcast domain.
- Configure a switch as the root bridge for each VLAN.
- Configure a switch as the secondary root bridge for each VLAN.
- Load sharing on uplinks.



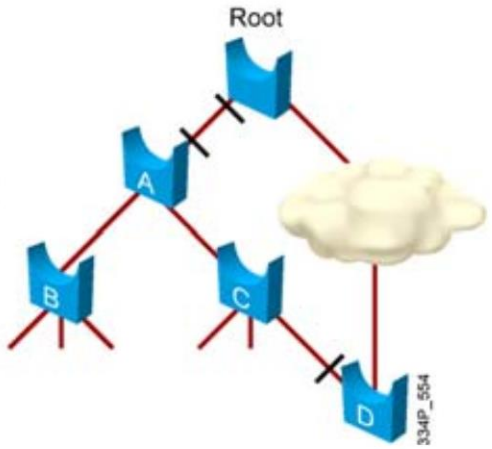
STP – State transitions

- Standard spanning-tree state transitions:

Standard spanning tree has no mechanism to determine when network has converged, blocking all transmissions for twice the forward delay.



New ports coming up on the root and switch A are immediately put in listening state, blocking traffic. BPDUs from the root start propagating toward the leaves through A

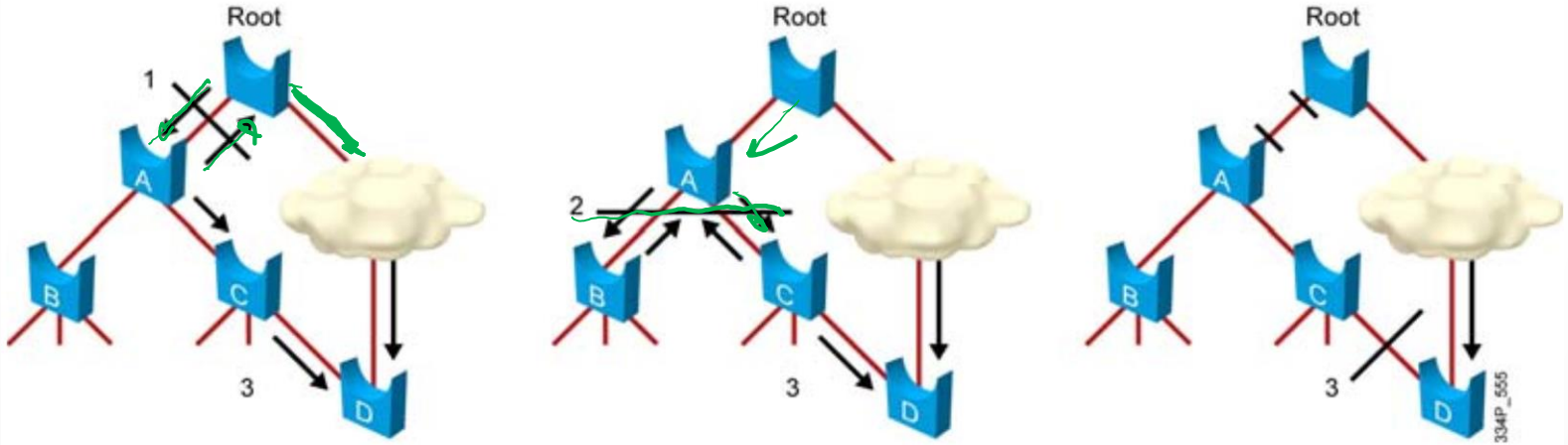


Very quickly, the BPDUs from the root reach D which immediately blocks its port P1. The topology has now converged, though the network is disrupted for twice the forward_delay value.

STP – State transitions

- RSTP state transitions:

Because RSTP relies on local negotiations, transition occurs as soon as the negotiation is completed.

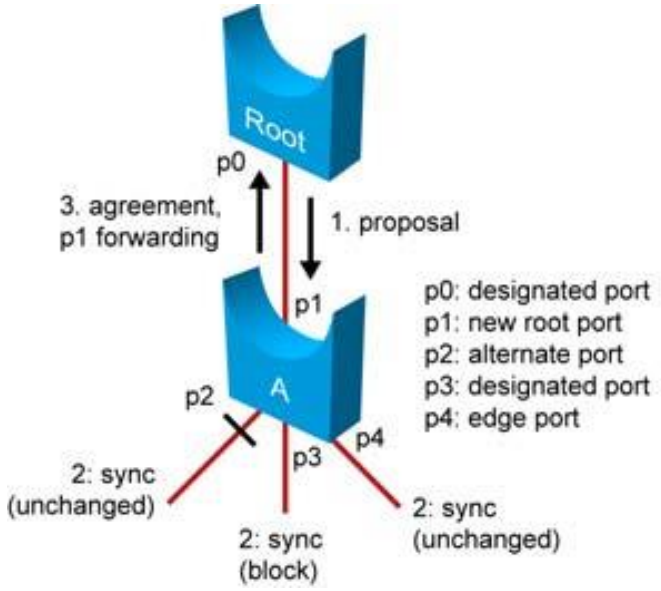


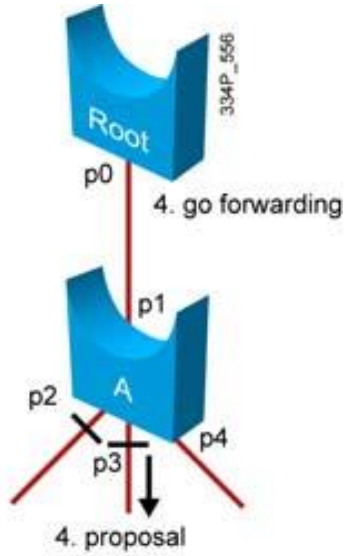
STP – State transitions RSTP

Ports negotiate locally as soon as different BPDUs are received.

Transition occurs as soon as negotiation is completed.

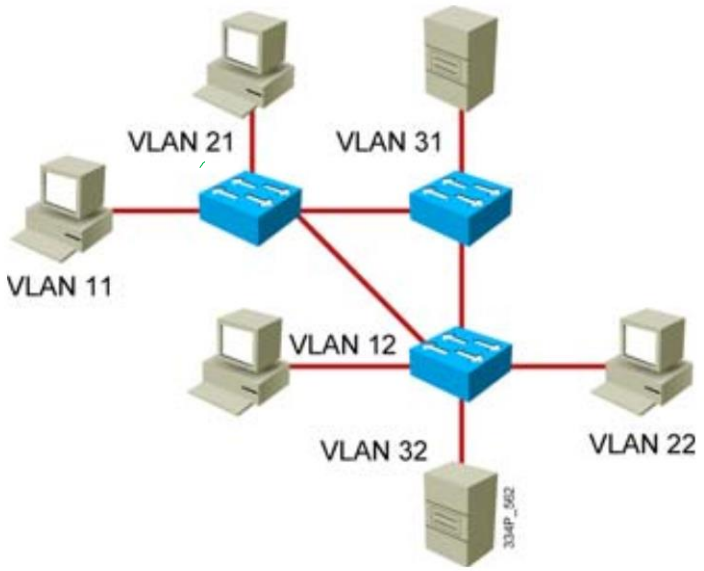
Negotiation is then immediately started on other ports.



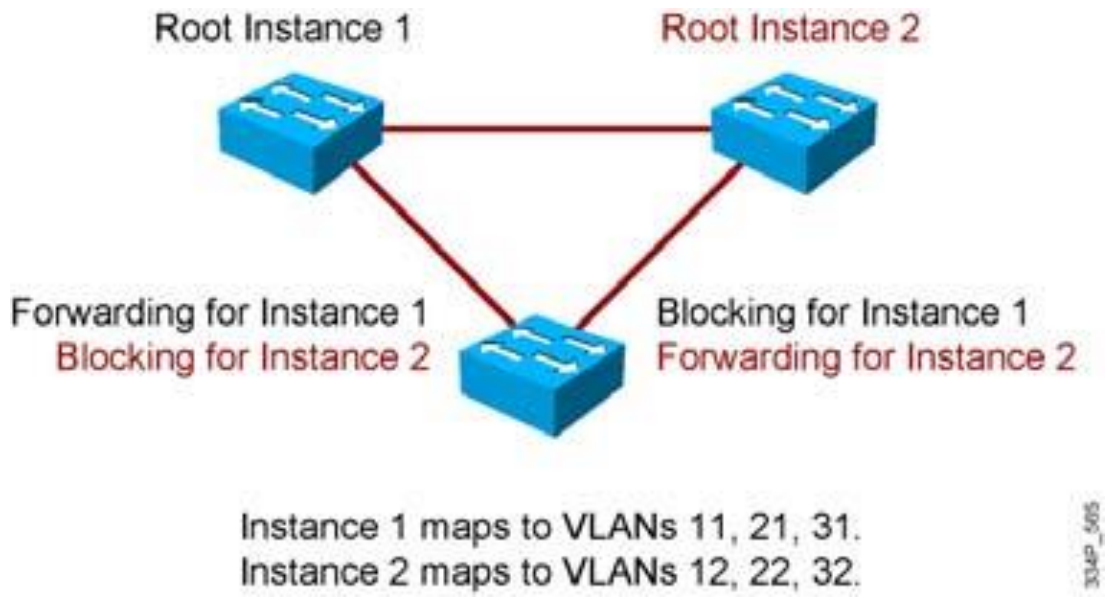


STP – Multiple Spanning Tree Protocol (MST)

- In some scenarios, many VLANs are spanning several switches.
- PVRST+ would need six instances.
- Grouping instances simplifies the tree structure.



STP – MST configuration

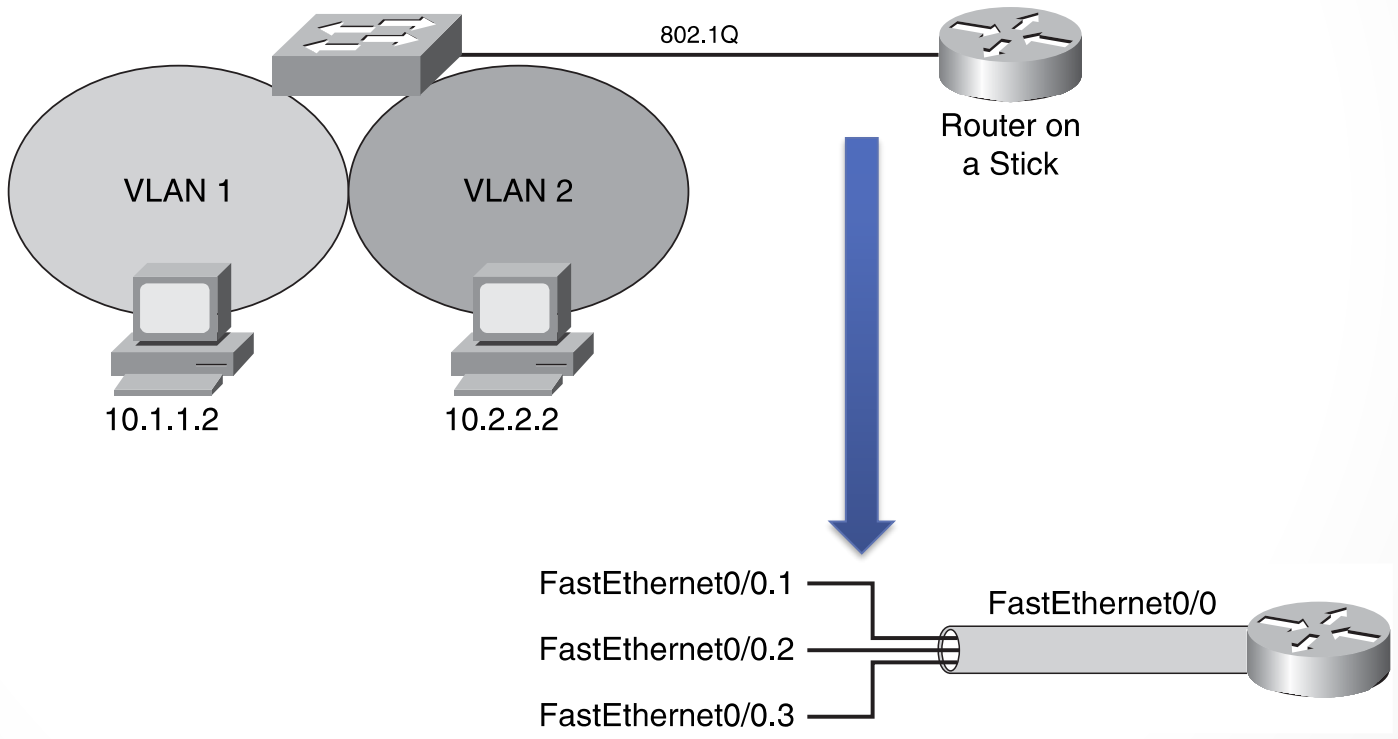


STP – Recommendations

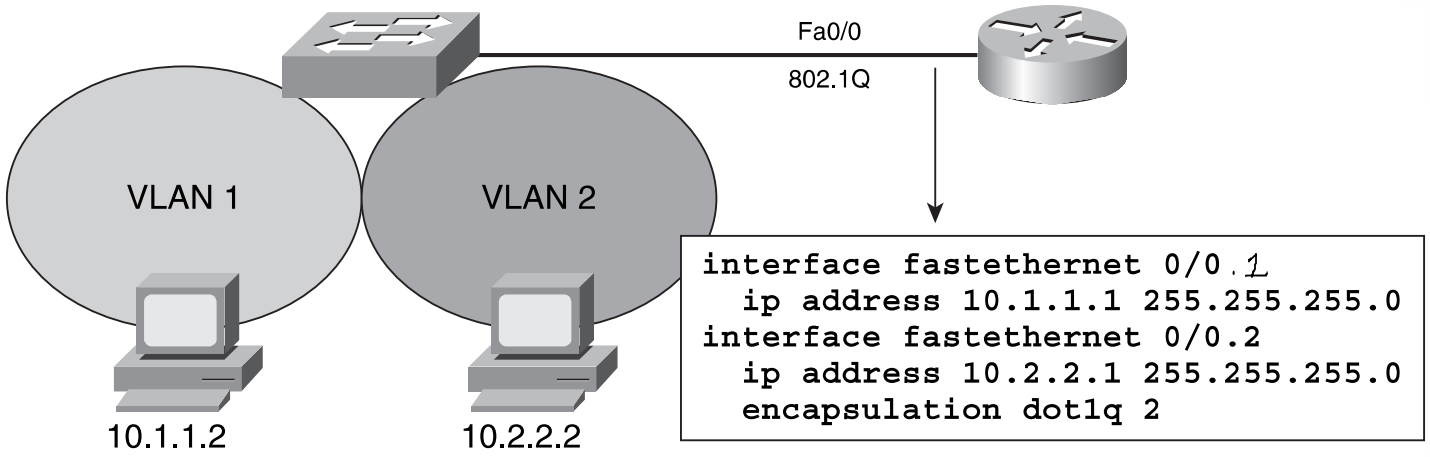
- Select a spanning-tree implementation:
  - RSTP—preferred solution.
  - MSTP.
  - STP.
  - PVST+.
- Recommendations for the Cisco Enterprise Campus Architecture:
  - Avoid Layer 2 loops, and use Layer 3 protocols to handle load balancing and redundancy.
  - Keep the spanning-tree domain as simple as possible.
  - Ensure that all links connecting backbone switches are routed links, not VLAN trunks.
  - Use multilayer switching to reduce the scope of spanning-tree domains.
  - Do not disable STP; keep it enabled to protect against loops.

Inter VLAN routing

Inter-VLAN communication occurs between broadcast domains via a Layer 3 device.



Inter VLAN routing configuration



Inter VLAN routing configuration

Advantages:

- Works with any switch, since Layer 3 services are not required on the switch.
- Implementation is simple.
- The router provides communication between VLANs.

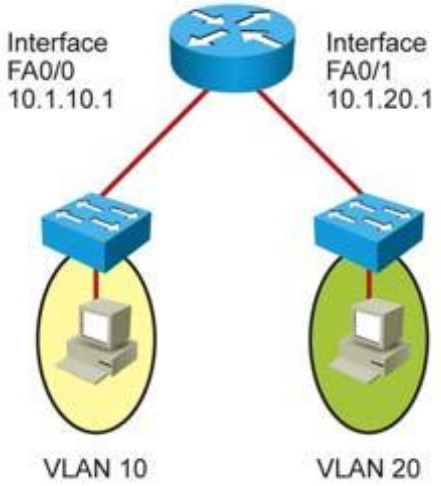
Disadvantages:

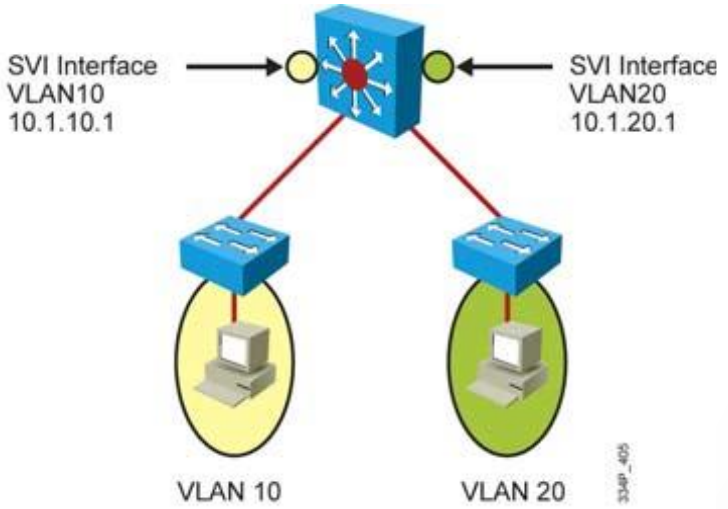
- The router is a single point of failure.
- Single traffic path may become congested.
- Latency may be introduced as frames leave and reenter the switch chassis multiple times, and the router makes software-based routing decisions.

Inter VLAN routing Switch virtual interfaces

Routers use interfaces or subinterfaces to interconnect multiple VLANs.

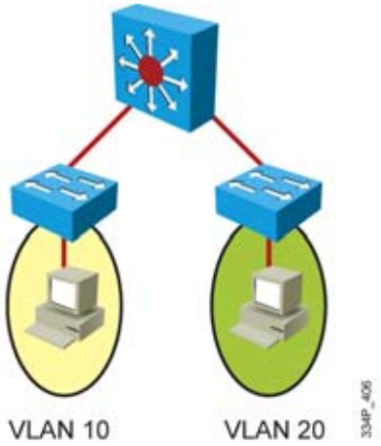
Multilayer switches use SVIs for routing between VLANs.





Inter VLAN routing SVI configuration

- Enable IP routing.
- Configure an SVI for each VLAN.
- Configure an IP address.
- Enable the SVI.
- Configure the routing protocol.




```
switch(config)# ip routing
switch(config)# interface vlan10
switch(config-if)# ip address 10.1.10.1 255.255.255.0
switch(config-if)# no shutdown
switch(config)# interface vlan20
switch(config-if)# ip address 10.1.20.1 255.255.255.0
switch(config-if)# no shutdown
```

Inter VLAN routing SVI configuration

The line state of an SVI is in the up state when:

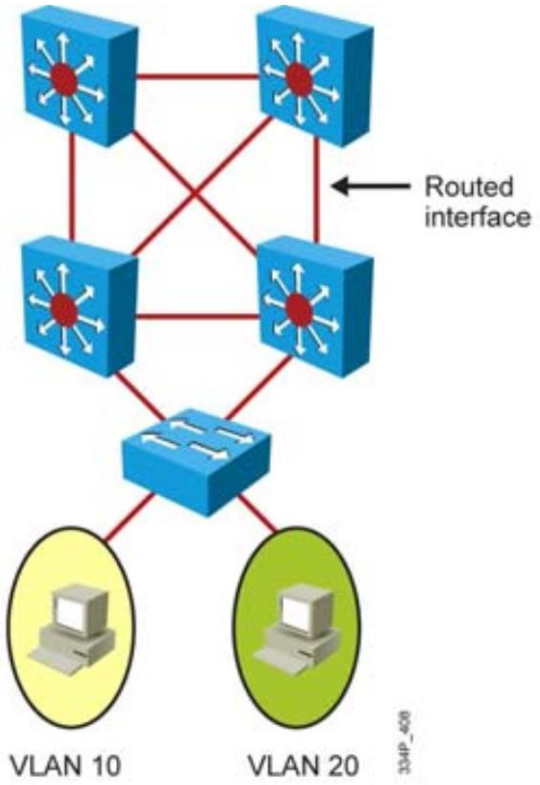
- The VLAN exists and is active in the VLAN database on the switch
- The VLAN interface exists and is not administratively down
- At least one Layer 2 (access or trunk) port exists, has a link in the up state on this VLAN, and is in the spanning-tree forwarding state on the VLAN

SVI **autostate exclude** can be used to remove a port from line-state up-and-down calculation.

```
switch(config)# interface fastethernet 0/24
switch(config-if)# switchport auto-state exclude
```

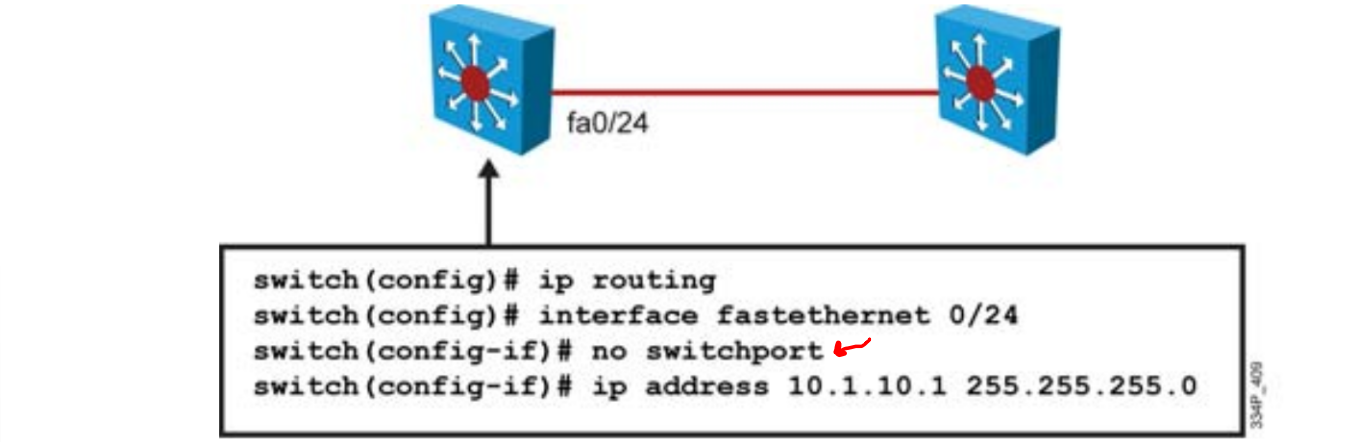
Inter VLAN routing - routed ports in multilayer Switches

- Physical switch port with Layer 3 capability
- Not associated with any VLAN
- Requires removal of Layer 2 port functionality
- Configured like a router interface but does not support VLAN subinterfaces
- Used when a switch has one port per VLAN or subnet only
- Useful for point-to-point Layer 3 switch links



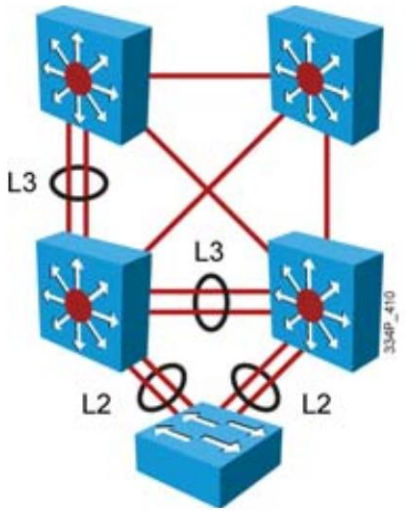
Inter VLAN routing - routed ports configuration

- Enable IP routing.
- Disable Layer 2 processing on interface.
- Configure IP address.



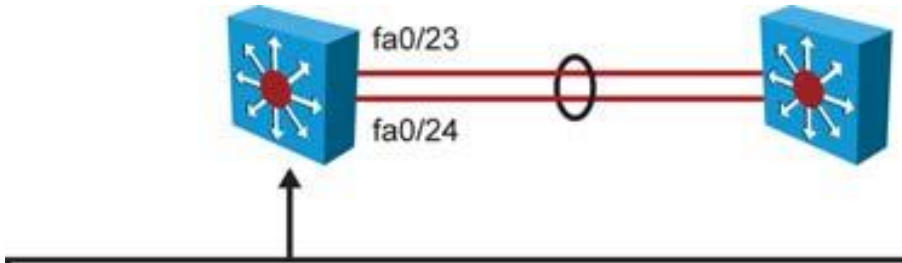
Inter VLAN routing - Layer 3 EtherChannel

- Layer 2 EtherChannel bundles access or trunk ports between switches or other devices (e.g., servers).
- Layer 3 EtherChannel bundles routed ports between switches.



Inter VLAN routing - Layer 3 EtherChannel

The **no switchport** command is applied both on the physical ports and on the EtherChannel interface.

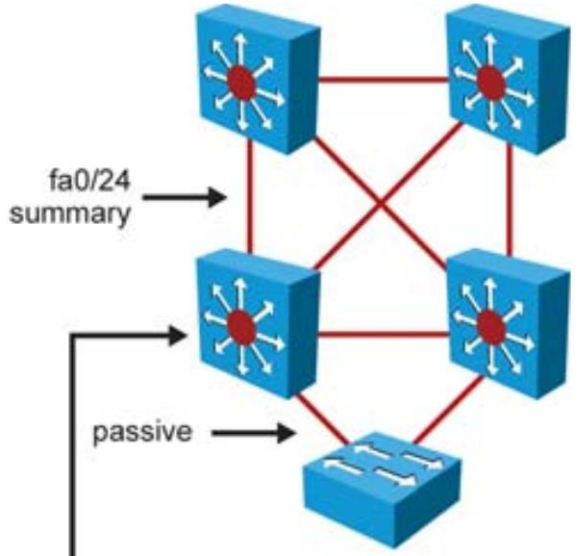



```
switch(config)# interface fastethernet 0/23
switch(config-if)# no switchport
switch(config-if)# channel-group 1 mode on
switch(config)# interface fastethernet 0/24
switch(config-if)# no switchport
switch(config-if)# channel-group 1 mode on
switch(config)# interface port-channel 1
switch(config-if)# no switchport
switch(config-if)# ip address 10.1.20.1 255.255.255.0
```

334P_411

Inter VLAN routing - Routing Protocol configuration

- Enable IP routing.
- Configure routing process.
- Disable auto-summary.
- Configure routed networks.
- Configure active interfaces.
- Configure summarization.




```
sw(config)# ip routing
sw(config)# router eigrp 100
sw(config-router)# no auto-summary
sw(config-router)# network 10.0.0.0
sw(config-router)# passive-interface default
sw(config-router)# no passive-interface fa0/24
sw(config)# interface f0/24
sw(config-if)# description Uplink
sw(config-if)# ip summary-address eigrp 100 10.1.0.0 255.255.240.0
```

334P_412

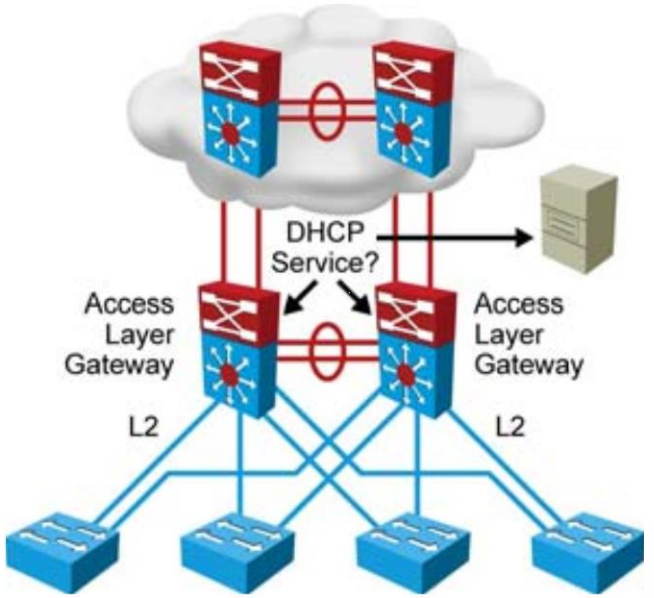
Inter VLAN routing - Routing Protocol verification

```
switch# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF,
       IA - OSPF inter area
       N1 - OSPF NSSA external type 1,
       N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1,
       L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default,
       U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
D       10.1.3.0/24 [90/28416] via 10.1.10.10, 08:09:49, Vlan10
D       10.1.2.0/24 [90/28416] via 10.1.10.10, 08:09:49, Vlan10
C       10.1.10.0/24 is directly connected, Vlan10
```

Inter VLAN routing - DHCP Service

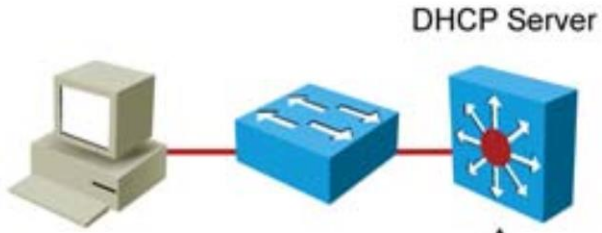
Clients in access VLANs need DHCP service.

DHCP service can be provided by the distribution switches, acting as gateways, or external DHCP server elsewhere in the network.



Inter VLAN routing - DHCP Configuration

- Configure DHCP pool with network, mask, and other parameters.
- Configure excluded addresses.
- Pool is selected when DHCP request is received from matching subnet.

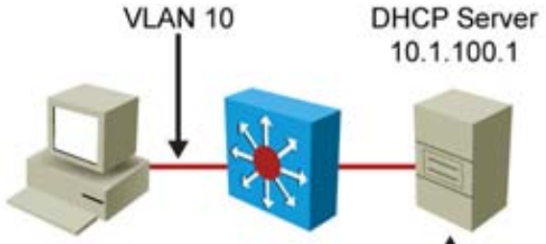



```
sw(config)# ip dhcp excluded-address 10.1.10.1 10.1.10.20
sw(config)# ip dhcp pool XYZ10
sw(config-dhcp)# network 10.1.10.0 255.255.255.0
sw(config-dhcp)# default-router 10.1.10.1
sw(config-dhcp)# option 150 10.1.1.50
sw(config-dhcp)# lease 0 8 0
sw(config-dhcp)# ! 0 days 8 hours 0 minutes
sw(config)# interface vlan10
sw(config-if)# ip address 10.1.10.1 255.255.255.0
```

→ IP Phone Server !

Inter VLAN routing - External DHCP

- Used if the DHCP server is not in the same broadcast domain as the client.
- Configure **ip helper** command on the incoming interface to forward DHCP requests via unicast to DHCP server.




```
switch(config)# interface vlan10
switch(config-if)# ip address 10.1.10.1 255.255.255.0
switch(config-if)# ip helper 10.1.100.1
```

Inter VLAN routing - Summary

- Inter-VLAN communication requires a Layer 3 device; an external router can perform this function.
- SVI is a virtual interface providing Layer 3 processing for a particular VLAN, similar to what a router interface does.
- To be active, the SVI number must match an existing VLAN on the local switch.
- A routed interface has Layer 3 functionality.
- SVIs and routed interfaces are verified using the same commands.
- On multilayer switches, you can aggregate Layer 3 links using Layer 3 EtherChannels.
- Once you have configured a Layer 3 interface, you can enable routing.
- DHCP functions can be configured with Cisco IOS Software.

Network Layer - Routing

- **Static:** The router learns routes when an administrator manually configures the static route. The administrator must manually update this static route entry whenever an internetwork topology change requires an update.

- **Dynamic:** The router dynamically learns routes after an administrator configures a routing protocol that helps determine routes.

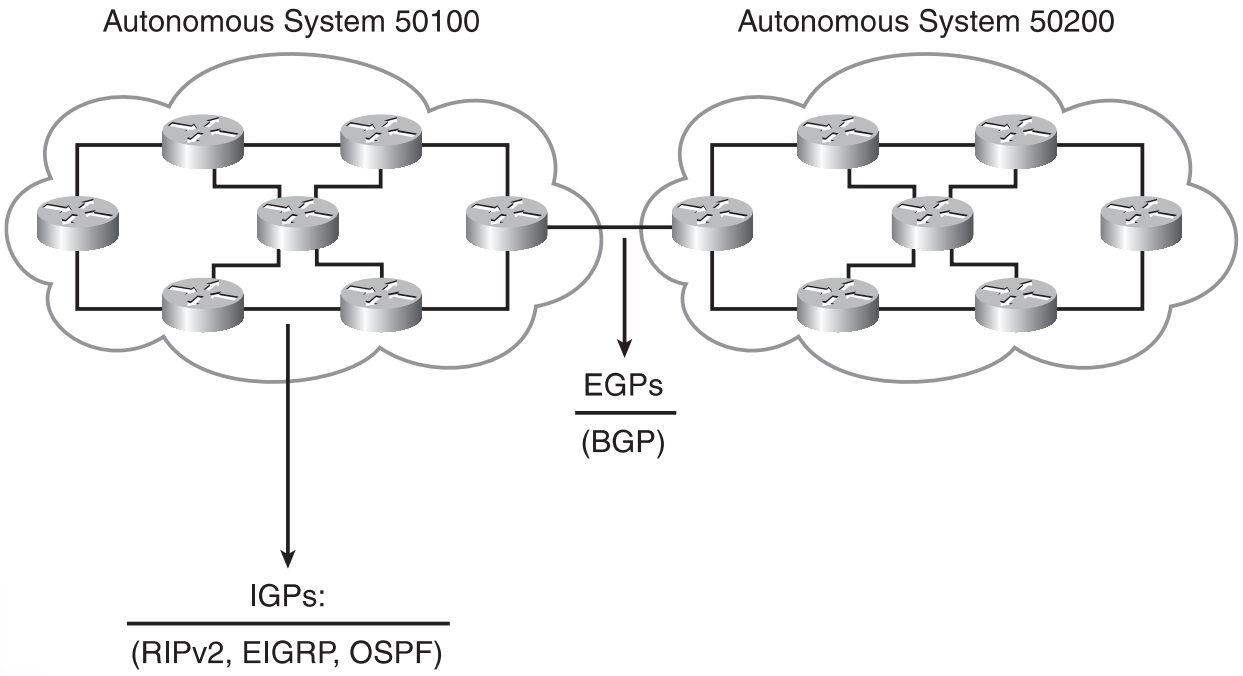
Routing protocol

describe the following information:

- How updates are conveyed
- What knowledge is conveyed
- When to convey the knowledge
- How to locate recipients of the updates

Network Layer – IGP and EGP

IGP Versus EGP



Network Layer – IGP and EGP

- **Distance vector:** The distance vector routing approach determines the direction (vector) and distance (such as hops) to any link in the internetwork.

- **Link-state:** The link-state approach, which utilizes the shortest path first (SPF) algorithm, creates an abstraction of the exact topology of the entire internetwork, or at least of the partition in which the router is situated.

- **Advanced distance vector:** The advanced distance vector approach combines aspects of the link-state and distance vector algorithms. This is also sometimes referred to as a hybrid routing protocol.

Routing protocols in the Network